

REMARKS

By the present amendment and response, independent claims 93 and 105 have been amended to overcome the Examiner's objections. Claims 93-117 are pending in the present application. Reconsideration and allowance of pending claims 93-117 in view of the following remarks are requested.

The Examiner has rejected claims 93 and 105 under 35 USC §112, second paragraph. Specifically, the Examiner states that "according to the drawings submitted by the applicant, there is no single embodiment in which the support pillar is simultaneously in the trench between two interconnect lines and situated between a first air gap and a second air gap, which are located in the same trench, while being in contact with the first interconnect line." Page 2 of Office Action dated July 28, 2003. Applicant respectfully disagrees with the Examiner for the reasons discussed below.

In reference to the exemplary embodiment of the present invention shown in Figure 35, the present application states:

"In another example, referring to FIG. 35, in the y-dimension a first air gap (e.g., 86A), a second air gap (e.g., first circle 86B), a third air gap (e.g., second circle 86B), and a fourth air gap (e.g., 86C) can be provided between a first interconnect line 70 and a second interconnect line 74 and support pillars 88B, 88C, and 88D can be provided between the air gaps in the y-direction." Page 13, lines 10-14 and Figure 35 of the present application.

Thus, as stated above and shown in Figure 35 of the present application, support pillar 88B is situated between a first air gap, i.e. 86A, and a second air gap, i.e. first circle 86B and the first air gap, i.e. 86A, and the second air gap, i.e. first circle 86B are situated

in a trench between first interconnect line 70 and second interconnect line 74. Further, as shown in Figure 35 of the present application, support pillar 88B is in contact with first interconnect line 70 as well as second interconnect line 74. Thus, for the reasons discussed above, Applicant respectfully submits that claims 93 and 105 meet the requirements of 35 USC §112, second paragraph.

The Examiner has rejected claims 93-117 under 35 USC §103(a) as being unpatentable over U.S. patent number 5,792,706 to Michael et al. ("Michael") in view of U.S. patent number 6,040,248 to Chen et al. ("Chen"). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by amended independent claims 93 and 105, is patentably distinguishable over Michael and Chen, either singly or in combination.

The present invention, as defined by amended independent claims 93 and 105, teaches, among other things, forming a first air gap, a second air gap, and a support pillar in a first hard mask, a second insulating layer (claim 105), and a first insulating layer, where the support pillar is situated between the first and second air gaps, where the first and second air gaps are situated in a trench "in a direction parallel to a length of said first interconnect line," where the support pillar is in contact with the first interconnect line, and "wherein said support pillar is formed to increase mechanical strength and thermal conductivity of said first interconnect line." As disclosed in the present application, the present invention can provide an interconnect having multiple air gaps between interconnect lines in various directions, such as both in a first direction, i.e. generally

parallel to a first interconnect line, and in a second direction, i.e. generally perpendicular to the first interconnect line.

As disclosed in the present application, the present invention can provide a support pillar situated between air gaps formed in a hard mask, where the support pillar and air gaps can have any shape, and where the support pillar is in contact with a first interconnect line. By appropriately controlling the size and shape of the first and second air gaps formed in the hard mask, the size and shape of the support pillar formed between the first and second air gaps in the first insulating layer can be advantageously controlled to advantageously achieve a desired increase in the mechanical strength and thermal conductivity of the first interconnect line. As a result, the present invention advantageously achieves a flexible interconnect structure that includes first and second air gaps to provide reduced inter-layer and/or intra-layer parasitic capacitance and a support pillar having an appropriate size and shape to increase the mechanical strength and thermal conductivity of an interconnect line in contact with the support pillar.

In contrast to the present invention as defined by amended independent claims 93 and 105, Michael does not teach, disclose, or suggest forming a first air gap, a second air gap, and a support pillar in a first hard mask, a second insulating layer (claim 105), and a first insulating layer, where the support pillar is situated between the first and second air gaps, where the first and second air gaps are situated in a trench “in a direction parallel to a length of said first interconnect line,” where the support pillar is in contact with the first interconnect line, and “wherein said support pillar is formed to increase mechanical

strength and thermal conductivity of said first interconnect line.” Michael specifically discloses forming air gap trenches 26 in first dielectric 20, where air gap trenches 26 extend between first interconnect lines 11. See, for example, column 6, lines 33-38 and Figure 6 of Michael. In Michael, trenches 26 are placed indiscriminately with respect to first interconnect lines 11. See, for example, lines 39-41 and Figures 6 and 7 of Michael.

However, Michael fails to teach, disclose, or suggest forming a support pillar between air gap trenches 26, where the support pillar is in contact with an interconnect line, and where the support pillar is formed to increase the mechanical strength and thermal conductivity of the interconnect line. Furthermore, Michael does not even mention forming a support pillar or similar structure between air gaps to increase the mechanical strength and thermal conductivity of an interconnect line. Moreover, by placing air gap trenches 26 indiscriminately with respect to first interconnect lines 11, Michael teaches away from intentionally forming a support pillar between adjacent air gap trenches, where the support pillar is in contact with an interconnect line and is provided to increase the mechanical strength and thermal conductivity of the interconnect line. Also, Michael fails to teach, disclose, or suggest a support pillar formed between air gaps, where the air gaps and support pillar are situated in a trench in a direction parallel to a length of an interconnect line.

In contrast to the present invention as defined by amended independent claims 93 and 105, Chen does not teach, disclose, or suggest forming a first air gap, a second air gap, and a support pillar in a first hard mask, a second insulating layer (claim 105), and a

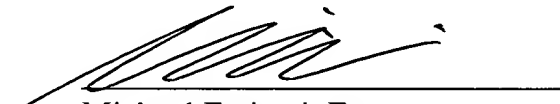
first insulating layer, where the support pillar is situated between the first and second air gaps, where the first and second air gaps are situated in a trench “in a direction parallel to a length of said first interconnect line,” where the support pillar is in contact with the first interconnect line, and “wherein said support pillar is formed to increase mechanical strength and thermal conductivity of said first interconnect line.” Chen is cited by the Examiner to disclose a silicon oxide hardmask, which is utilized to etch a contact opening in an organic layer. However, the addition of Chen fails to overcome the deficiencies in Michael discussed above.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by amended independent claims 93 and 105, is not suggested, disclosed, or taught by Michael and Chen. Thus, amended independent claims 93 and 105 are patentably distinguishable over Michael and Chen and, as such, claims 94-104 depending from amended independent claim 93 and claims 106-117 depending from amended independent claim 105 are, *a fortiori*, also patentably distinguishable over Michael and Chen for at least the reasons presented above and also for additional limitations contained in each dependent claim.

Based on the foregoing reasons, the present invention, as defined by amended independent claims 93 and 105 and claims depending therefrom, is patentably distinguishable over the art cited by the Examiner. Thus, claims 93-117 pending in the present application are patentably distinguishable over the art cited by the Examiner. As such, and for all the foregoing reasons, an early allowance of claims 93-117 pending in the present application is respectfully requested.

Respectfully Submitted,
FARJAMI & FARJAMI LLP

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